DaimlerChrysler AG

Patent Claims

1. A method for predicting the voltage of a battery, having the following steps:

(S1) detection and checking of battery data, by detection and calculation devices, with the battery data comprising a battery voltage (U_batt), a battery current (I_batt), a battery temperature (T_batt) and a dynamic internal resistance (Rdi),

(S2) checking whether the present functional procedure is a first procedure,

(S3) if the result in step S2 is that a function procedure has already been carried out, checking whether a predetermined time (Tx) has elapsed, and, if the predetermined time has not yet elapsed, returning to step S1,

(S4) if the predetermined time (Tx) has elapsed, filtering of the battery voltage (U_batt) and of the battery current (I_batt) by means of a low-pass filter, and emission of a filtered battery voltage (U_filt) and of a filtered battery current (I_filt),

(S5) checking whether the filtered battery current (I_filt) is greater than a predetermined load (I_pred) minus a tolerance (Tol), and whether the battery current (I_batt) is greater than a predetermined load current (I_pred) minus the tolerance (Tol) and, if the conditions are not satisfied, returning to step S1,

(S6) calculation of a resistive voltage drop (U_ri) across the dynamic internal resistance (Rdi),

(S7) calculation of a polarization voltage (U_pol) as a function of the filtered battery current (I_batt_filt),

(S8) filtering of the polarization voltage (U_pol), by means of two low-pass filters separately on the basis of a fast settling component (U_pol_fast_raw) and a

slowly settling component (U_pol_slow_raw) and emission of a filtered polarization voltage (U_pol_filt),
(S9) calculation of a predicted battery voltage by subtracting the resistive voltage drop (U_ri) and the filtered polarization voltage (U_pol_filt) from the filtered battery voltage (U_batt_filt),
(S10) limiting of the predicted battery voltage (U_pred) determined in step S9 upwards and downwards,
(S11) filtering of the predicted battery voltage (U_pred), and
(S12) checking whether the bit which indicates that a first function call has been carried out is set and, if not, setting the bit and returning to step S1, or, if yes, returning to step S1.

2. The method for predicting the voltage of a battery as claimed in claim 1,
characterized
in that
the dynamic internal resistance (Rdi) is determined by means of a buffer algorithm.

3. The method for predicting the voltage of a battery as claimed in claim 1 or 2,
characterized
in that the predetermined time (Tx) in step S3 is 500 ms.

4. The method for predicting the voltage of a battery as claimed in one of claims 1 to 3,
characterized
in that the filtered battery voltage (U_filt) and the filtered battery current (I_filt) are obtained from the following equations:

$$U\_filt(t_n) = (U\_batt - U\_filt(t_{n-1}))*(1 - \exp(-t/T)) + + U\_filt(t_{n-1})$$

$$I\_filt(t_n) = (I\_batt - I\_filt(t_{n-1}))*(1 - exp(\_t/T)) + + I\_filt(t_{n-1})$$

where T is a filter constant, t is an interval in which a value record is in each case read and t_n is the actual time, while t_{n-1} is the time of the last calculation.

5. The method for predicting the voltage of a battery as claimed in one of claims 1 to 4, characterized in that the steps S3 and S4 are jumped over in a first function call directly after a start.

6. The method for predicting the voltage of a battery as claimed in one of claims 1 to 6, characterized in that the tolerance (Tol) is chosen to be 5 A.

7. The method for predicting the voltage of a battery as claimed in one of claims 1 to 6, characterized in that the resistive voltage drop is calculated using the following equation:

$$U\_ri = (I\_filt - I\_pred) * Rdi$$

8. The method for predicting the voltage of a battery as claimed in one of claims 1 to 7, characterized in that the polarization voltage (U_pol) is calculated taking into account the stated conditions using the following equations:

If I_filt > 0:

U_pol = (U_pol_0 + (ki_lad*I_filt/(ik_lad + I_filt))) * * K_i.

If I_filt ? 0:
U_pol = (U_pol_0 + (ki_ela*I_filt/(ik_ela - I_filt))) * * K_1,

where K is a correction factor which is dependent on the predetermined load (I_pred), and the parameters U_pol_0, ki_lad, ik_lad, ki_ela and ik_ela are predetermined parameters which have been determined empirically, and ki_ela can be defined such that the value of the polarization voltage (U_pol) is 0 V if the filtered battery current (I_filt) is equal to the predetermined load current (I_pred).

9. The method for predicting the voltage of a battery as claimed in one of claims 1 to 8,
characterized
in that the polarization voltage (U_pol) has a fast settling component (U_pol_fast_raw) and a slowly settling component (U_pol_slow_raw), with the fast settling component (U_pol_fast_raw) making up 60% of the polarization voltage (U_pol) and the slowly settling component (U_pol_slow_raw) making up 40% of the polarization voltage (U_pol), and each of these two components being filtered by a low-pass filter in step S8, thus resulting in the following equations:

U_pol_fast_filt(t_n) =	(U_pol_fast_raw - - Upol_fast_filt(t_{n-1}) * * T + U_pol_fast_filt(t_{n-1})

U_pol_slow_filt(t_n) =	(U_pol_slow_raw - - Upol_slow_filt(t_{n-1}) * * T + U_pol_slow_filt(t_{n-1})

and the overall filtered polarization voltage (U_pol_filt) being obtained by addition of the two filtered components of the polarization voltage (U_pol_fast_filt, U_pol_slow_filt).

10. The method for predicting the voltage of the battery as claimed in claim 8,
characterized
in that the correction factor K_1 is unity when the predetermined load current (I_pred) is -100 A, while it is obtained from (1-(I_pred + 100)/100*0.2) for a predetermined load current (I_pred) between -80 A and -150 A.